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FIRE PREVENTION in Hospitals

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FIRE PREVENTION in Hospitals

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FIRE safety is so important to all hospital administrators, employes and designers that the leadership in the hospital field should make every effort to keep abreast of current developments in the fire safety field. Each of these person's actions, no matter how routine, may have an important bearing on the total fire safety environment of the hospital's occupants.

Fires continue to occur in hospitals. Fortunately, most of the fires are small, are discovered early, and are extinguished promptly. However, no one can predict just when one of these minor occurrences will get out of hand and cause a major disaster.

The immediate effect of such a disaster is re-examination of the rules applying to fire prevention and fire protection. Frequently, because of the emotional reaction to the disaster, amendments to the rules overcompensate for previous deficiencies. Such extremes are neither desirable nor necessary. It would be much better if the basic principles of fire safety were constantly kept in mind during the design, construction, operation and maintenance of each hospital facility.

Planning for fire safety can be divided into five steps: minimizing the chance of fire, early discovery, restricting fire spread, extinguishing the fire, and evacuating the building.

Minimizing the Chance of Fire

The most effective contribution the building designer can make toward fire prevention is in the selection of proper materials and equipment. All materials used in building a hospital should be incombustible.

Fabrics, trim and finishes, which because of esthetics or function cannot comply with this requirement, should be properly treated to reduce their combustibility. The fewer combustibles that can be used and the more combustibles that can be flameproofed, the safer will be the patients in the hospital room or ward and the hospital personnel taking care of them.

The proper selection and installation of equipment is very important in promoting high standards of maintenance and operation, thereby removing many chances of accidental fires. (Table 1 lists the causes of hospital fires.)

Sufficient space is required around and above all mechanical equipment and electrical services to permit safe operation and to encourage good maintenance. If equipment is placed in inaccessible locations, it will not receive adequate maintenance. Machinery that does not operate smoothly, hot bearings, parts that are broken, parts not properly aligned, or loose pieces of metal can cause friction, heat and sparks that will lead to excessive wear or fire. It is good hospital design practice, therefore, to increase ceiling heights in kitchens, laundries, boiler rooms, mechanical equipment rooms, and similar spaces.

Fuel-fired equipment should be properly designed, adequate in size, and correctly installed. Electrical devices, appliances and equipment should be of approved types and should be installed, operated and maintained in accordance with the manufacturers' recommendations.

Hospital refrigerators are often used to store flammable liquids with low boiling points. These liquids can cause an explosive mixture that is ignited when the thermostat operates or the doors are opened and the electric switch for the interior light operates. Numerous explosions are caused by storing ether and similar chemicals in ordinary refrigerators. Such refrigerators can be made safe by the removal of all interior wires and switches. In purchasing refrigerators, only those which are safe to use in explosive atmospheres should be considered.

Proper facilities for the handling and disposal of linen and trash will do much to minimize the chance of a hospital fire. Adequate space and an organized routine to prevent the untidy storage of laundry is important. In like manner the hospital employes should be trained in the proper disposal of hazardous waste materials.

In one case, a hospital attendant was burning dry picric acid when the pile detonated. It shook the town so badly that water pipes broke. In another case, ether cans detonated as an attendant was dumping the contents of a trash can into an incinerator. He received only minor burns because he was partially shielded by the trash can and because he wore a face shield.

In another case, a hospital employe detected the sound of leaking gas from the safety plug of an oxygen cylinder in a hospital nursery. He attempted to tighten the safety plug with an oily adjustable wrench which he left in contact with the plug. A few minutes later he heard a sharp sound, then noticed molten metal flying through the air, some falling on the babies' beds. Fortunately, he was able to remove the babies unharmed from the nursery while

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others extinguished the fire. This near catastrophe was caused by the well-known oxygen-organic reaction and illustrates two important points. Unauthorized people should never attempt to tighten cylinder safety devices and oil or grease should not be permitted to contact oxygen fittings, regulators or valves.

Early Discovery

Although elementary, it is important to realize that almost all large fires start from small ones. For this reason, the earlier the fire is discovered and the sooner extinguishing action is begun, the smaller the danger.

In areas where someone from the hospital staff is on duty at all times, the fire is likely to be discovered early. Prompt action in applying proper extinguishing technics will result in minimum excitement and loss. Certain hospital areas, however, are not under constant staff supervision, whereas other hospital areas may be considered of greater than normal fire risk because of their content or use. (Table 2 shows the locations where fires originate.) In such cases, installation of automatic fire detection and alarm systems is highly desirable.

Such systems may be necessary in the large general storage rooms, various maintenance shops, trash collection rooms, and the corridors serving these areas.

Several basic types of systems are available and can be classified as follows: smoke-detection alarm, heat-actuated alarm, automatic water-sprinkler, and automatic chemical extinguishing.

Several factors enter into the selection of the proper type of system for each application. For example, rooms containing intricate machinery or expensive supplies should be protected by a system which will not damage the contents of a room. For conditions that are conducive to a rapid spread of fire, a water sprinkler or chemical extinguishing system would be most appropriate since it discovers the fire, applies an extinguishing medium, and can be arranged to sound an alarm as well.

All hospital buildings (except the very smallest ones) should be provided with an internal fire alarm system. Such a system gives immediate notice to the hospital staff and employes and all other building occupants of a fire on the premises. If the local fire authorities permit, the system should be interconnected to transmit an alarm to the municipal fire department in order to eliminate any possible delay in calling them.

Some alarm systems have incorporated a presignal feature that sounds an initial alarm only in selected locations with provisions whereby authorized persons may subsequently sound a general alarm. This presignal feature is *not* recommended for hospital occupancies since it serves to delay the general alarm, and experience has shown that delayed alarms frequently result in loss of life and property.

Some authorities are unduly concerned about the effect of harsh strident sounds of fire bells or gongs on certain types of patients. To minimize this possibility, the use of visual signal alarm panels is permitted in patient sleeping areas. In this case, enough visual signals should be distributed throughout the nursing unit to provide adequate warnings to the staff and should be located in corridors, nurses' stations, utility rooms, pantries and other workrooms. However, most fire authorities believe that an audible signal is preferable to a visual signal and would recommend that soft chimes or small bells be used.

The paging or normal communication system is a useful adjunct at a time of fire emergency for issuing instructions and organizing the resources of the hospital to best meet the individual emergency at hand. It should not be used as an alerting system to notify key people in the hospital of the fire prior to the activation of the building alarm, since this is in effect delaying the alarm.

Table 1 — Causes of Hospital Fires

	Per Cent of Fires	
Electrical		22.6
Fixed services, wiring, defective	11.2	
Power consuming appliances, defective, mishandled	10.2	
Static sparks	1.2	
Cigarets, matches, careless use		20.9
Heating system defects (including chimneys)		11.5
Oxygen or nitrous oxide, mishandling		7.4
Spontaneous ignition		7.4
Flammable liquids, mishandling		6.6
Combustible anesthetic agents, mishandling		4.9
Kitchen fire hazards		4.1
Incendiary (arson) or suspicious		3.0
Combustible material too close to heating equipment		2.4
Incinerators, defective		2.4
Gas piped to or in building, leakage and ignition		1.2
Lightning		0.8
Rubbish, grass, brush fires, sparks from		0.8
Welding or cutting equipment, careless use		0.8
Sparks from chimney		0.4
Roofing equipment, careless use		0.4
Miscellaneous other known causes		2.4
Total		100

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Restricting Fire Spread

The hospital fire emergency plan will usually direct the employe who discovers the fire first to remove any occupants from the room involved, close the door, and then sound the alarm. The purpose of closing the door is to try to confine the fire to its point of origin until the fire-fighting processes can be brought into play. Therefore, rooms should be considered as sealed units with no communicating openings to other rooms or other parts of the building except for the necessary ventilation duct openings.

Furred spaces behind wall finishes and other concealed spaces should be suitably fire-blocked to preclude the passage of smoke and gases from one room to another. Solid wood doors or their equivalent are recommended for hospitals because they have retarded the spread of many hospital fires. Doors should be equipped with door closers or latching devices. Roller latches may be used on patient room doors and would be expected to perform satisfactorily if kept properly adjusted. Vision panels in corridor walls should be glazed with wire glass.

A mechanical system that uses the corridor as a plenum for the supply or exhaust of ventilating air to individual rooms is not recommended for hospitals because this directly conflicts with good fire safety practice. This type of system requires the use of undercut doors and louvered panels or ventilating transoms in the corridor walls, which would make it impossible to confine the fire or smoke to an individual room.

For a number of reasons it may not be possible to confine all fires to individual rooms until they can be controlled by organized fire-fighting services. It is, therefore, recommended that each floor be subdivided into at least two compartments by providing a fire-resistive partition horizontally from sidewall to sidewall and vertically from floor to floor above. Such partitions are called smoke barriers. In large buildings no more than 150 feet of corridor without such smoke barriers should be permitted.

Where such smoke barriers cut across corridors, a pair of close-fitting solid wood or equally solid type doors should be installed. These doors should be equipped with door closers and held open during normal operation of the hospital by devices which will release the doors in the event of a fire emergency. The devices should be arranged to permit the closing of the doors manually, by activation of the building fire-alarm system, and by smoke-detection systems.

In addition to the hazard to the occupants on the same floor as the fire, at times as great a danger exists from asphyxiation to the people on floors considerably removed from the floor on which the fire occurs. Many lives have been lost this way. (Table 3 lists type and frequency of hospital injuries caused by fire.)

A classic example is the fire in a basement storage room containing nitrocellulose x-ray film at Cleveland Clinic in 1929. The fire caused the deaths of 125 persons out of approximately 250 occupants in the clinic when the deadly gases spread throughout the four-story building by way of pipe tunnels, non-fire-stopped pipe chases, and an unen-

Table 2 — Origin of Hospital Fires

	Basement	First Story	Upper Story	Attic Roof	Totals
Service Areas					
Kitchen	5	6	3	..	14
Storeroom (inc. janitor rm.)	14	6	3	..	23
Closet	1	2	2	..	5
Laundry	3	2	1	..	6
Laundry, waste or other chute	10	2	3	..	15
Heating power	20	3	..	7	30
Elevator or dumb-waiter shaft	7	..	1	8	16
Carpentry, maintenance shop	4	1	..	..	5
Linen room	2	2	2	..	6
Incinerator room or flue	6	..	2	2	10
Nurse or employe quarters	..	..	2	1	3
Other (corridor, stairway, etc.)	7	5	9	3	24
Patient Areas					
Room	..	2	13	..	15
Ward	..	1	9	..	10
Recreation	..	..	1	..	1
Other	..	..	4	..	4
Special Areas					
Laboratory	4	1	2	..	7
X-ray room	2	1	..	..	3
Operating, delivery room	..	2	17	..	19
Sterilizing room	..	1	5	..	6
Croup tent (patient room)	..	..	2	..	2
Oxygen tent, mask or room	..	1	23	..	24
Other	..	2	3	..	5
Auxiliary Buildings					
Heating or power plant	..	3	..	..	3
Nurse or employe quarters	3	2	11	1	17
Administration, recreation	..	..	..	..	..
Exposure	..	..	..	..	1
Other	3	4	..	..	7
Specific use unknown	1	..	1	5	7
No information	..	..	..	..	12
Totals	92	49	119	27	300

Source: NFPA Fire Record Bulletin FR 61-1. Copyright by and available from National Fire Protection Association, Boston, 1961.

closed decorative light well extending from the first floor to the roof.

To isolate each story in an effective manner, all stairways, elevator shafts, dumb-waiters, ventilating shafts, chutes and other vertical openings must be properly enclosed at each floor. Fire doors should be used on all openings into these enclosures. Door closers should be used on all doors to ensure that the door will close after each use. The administrator should remove all wedges that are used to hold open any fire door and should initiate a policy to keep these doors closed.

Fire doors are required to isolate areas of greater than normal hazard from the remainder of the structure. These doors are especially designed to resist the passage of fire through the openings, in the walls or partitions in which they are installed. Doors should be labeled or otherwise marked to show that they meet the standard requirements for the various classifications of openings. Class B fire doors should be used for openings in vertical enclosures such as stairs and elevators and in rooms of high hazard occupancy, whereas Class C doors would generally be found in low hazard occupancy rooms.

Several types of fire doors are available. However, in hospitals only the swinging type should be used and they should be arranged to open in the direction of exit travel in such a manner as not to obstruct the corridor or the operation of other doors. Properly installed swinging doors are easier to operate under emergency conditions than any other type and permit rapid egress for persons who must be assisted in the evacuation process.

Fire-fighting authorities say that the outcome of a fire can usually be foretold by the type of fire fighting attempted on the blaze. Many building fires, if discovered at an early stage, may be held in check, if not completely put out, by persons reasonably well-trained in the handling of fire extinguishers.

Certain types of fires, if not handled promptly or if not handled properly at their start, may quickly become a threat to the entire population of the building. For this reason, each hospital should be properly equipped with fire extinguishers and the hospital administration should follow through the requirements of its fire emergency plan and train as many employes as possible in the use of these extinguishers. It should be understood that a fire extinguisher is a first-aid appliance and is designed for a limited use pending the arrival of the organized fire services.

Most fires can be classified as being primarily one of three general types. A fire in ordinary combustible materials (wood, paper, fabric) is called a Class A fire and one of the best ways for putting out such a fire is by quenching with water and thereby reducing the temperature of the burning material below its ignition point. Fires in flammable liquids and greases (oils, gasoline, paint) are listed as Class B fires and are best handled by a blanketing technic which tends to keep oxygen from the fire and thereby suppresses combustion. Fires in the electrical equipment (motors, controls, panels, wiring) are Class C and are usually combinations of the previous types, but because of the hazard of electrical short circuits, it is important to use a nonconducting extinguishing agent.

Several types of fire extinguishers are available but all are not equally effective upon the different kinds of fires. For convenience and economy of maintenance and to reduce the problem of employe training, it is suggested that the hospital administration select the fewest types of extinguishers for distribution throughout the building. It is possible to use two types for all classes of fires. (Table 4 lists types of fire extinguishers for Class A, B and C fires.)

The local fire-fighting authorities can provide valuable assistance in the selection of the proper extinguishers, sizes and types, and are generally in a position to assist in the training of hospital personnel in the proper use of this equipment.

Table 3 — Fatal and Nonfatal Hospital Injuries Caused by Fire

	Per Cent of Fatal Injuries	Per Cent of Nonfatal Injuries*
Bodily Burns From Flames (Contributing factors — trapped by explosion or rapid spread of fire; no automatic protection; bedridden or other physical handicap, mentally deranged or under restraint; smoking in presence of oxygen; left unattended in oxygen or croup tent; mishandling of oxygen or flammable liquids.)	27	39
Suffocated or Overcome by Smoke or Fire Gases (Contributing factors — inadequate exit facilities; trapped by explosion or rapid spread of fire; no automatic protection; bedridden or other physical handicap, mentally deranged or under restraint; fire fighting; attempted rescue.)	64	43
Explosions (Ignition of combustible anesthetic agents by static sparks, cautery, etc.)	9	8
Other	0	10
Totals	100	100

*Includes 35 per cent fire fighters.

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Planning for Evacuation

If a hospital fire can be confined to its point of origin, it can be brought under control before occupants are harmed. Fortunately, numerically, most hospital fires are in this category. If a fire should persist, it then may be necessary to remove patients from their usual locations to safer portions of the building. Since the time, extent or duration of an accidental fire cannot be predicted, plans should be made for sufficient and adequate exit facilities in every hospital.

The usual rules for exits in hospital buildings are well-understood: 44 inch wide door openings, 8 foot corridors, exit stairways located at the end of each corridor to preclude dead ends where occupants may be trapped, stairways discharging directly to the outside at grade or into a safe corridor on the first floor which leads to the street, and proper lighting and signs for exitways.

Not so well-understood is a planning technic which may obviate the need for an extensive evacuation procedure or, if total evacuation is necessary, will afford more time with less risk to the patients. This is the principle of compartmentation.

Compartmentation simply means the division of a floor area into two or more subareas by the use of transverse fire-resistive partitions and corridor doors. These corridor doors are kept open by suitable hold-open devices during all times except in a fire emergency and therefore do not interfere with the day-to-day operation of the hospital.

The value of compartmentation from a timesaving point of view is readily demonstrable. If a nursing floor, without compartmentation, containing 40 patients must be evacuated, the staff must see that each patient is assisted at least to the floor below. The time to accomplish this total floor evacuation would depend upon the number of staff available and the condition of the patients on the floor. If the 40 bed nursing unit is divided into two compartments, the primary evacuation would involve only 20 patients from the compartment in danger through the cutoff doors to the safer compartment on the same floor. The time saved in moving 20 patients horizontally compared with 40 patients vertically is readily apparent.

Hospital designers may wish to compartmentalize their elevator circulation. This may make the elevators available for evacuation for a longer period of time in case of fire emergency and also would provide a sound barrier between the noisy elevator circulation and patient units.

A hospital complex is a chain of many disciplines performing their functions under stressful circumstances. It would not be reasonable to expect such an environment to be free from the possibility of fire. Each link in this chain, therefore, is a potential fire risk.

Although we will continue to have fires in our hospitals, we should strive to have no loss of life. Experience in past fires has indicated that loss of life could have been prevented by adherence to fire-safety recommendations.

Hospital designers in planning new buildings and hospital administrators in developing ideas for modernization and remodeling projects should give prime consideration to fire-safety rules. A weak link could spell disaster! ■

Table 4 — Types of Fire Extinguishers

Type of Extinguisher	Contents	Recommended for Class of Fires (See note below)		
		A	B	C
Soda-Acid	Bicarbonate of soda powder Water Sulfuric acid	x		
Pressurized Water	Plain water Carbon dioxide cartridge	x		
Foam	Bicarbonate of soda Foam stabilizing agent Water Aluminum sulfate	x	x	
Loaded Streams	Alkali-metal-salt solution	x	x	
Vaporizing Liquid*	Carbon tetrachloride		x	x
Carbon Dioxide	Carbon dioxide under pressure		x	x
Standard Dry Chemical	Dry chemical Carbon dioxide cartridge		x	x
Multipurpose Dry Chemical	Dry chemical Carbon dioxide cartridge	x	x	x

*Caution: Not recommended for indoor use. Do not use extinguishers of this type in small rooms or confined spaces because of the toxicity of the liberated or produced vapors and gases.

Note:
Class A fires are those in ordinary combustibles (wood, paper, etc.)
Class B fires are those in flammable liquids (oil, gasoline, paints, etc.)
Class C fires are those in electrical equipment.

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